

### **WHAT IS CLAIMED IS:**

1. An apparatus that amplifies vibrations that are produced by an actuator, comprising;
  - a. a horn that forms two or more parallel acoustic paths and possesses two surfaces perpendicular to the extension, one connected directly to an actuator for mechanical input power and the other free for mechanical power output,
  - b. a horn with at least one change in direction that amplifies the vibration strain from an actuator.
2. The horn of claim 1, where the folded horn is configured axis-symmetric or planar with respect to axis of extension.
3. The horn of claim 1, further comprising of a stack of piezoelectric or electrostrictive elements that are configured concentric and external to the horn.
4. The horn of claim 1, comprised of an electroactive stack that is encircled by the horn as a compact modality of the actuator.
5. The horn of claim 1, comprised of a hollow core as a passage for transfer of materials from one side to the other.
6. The folded horn of claim 2, further comprising an adjustable fold thickness design for adjusting the bending contribution to the overall extension.
7. The folded horn of claim 2, further comprising of a reflector connected to the base of the folds for enhanced vibration amplification and control of the phase of the strain.

### **ABSTRACT**

The present invention provides a design of a horn for vibration actuators. In general a driving actuator generates vibrations and a horn amplifies the vibration amplitude where the amplification is related to the ratio between the surface area of the horn at the contact with the actuator and the tip surface. The acoustic path of existing direct horn designs is modified to adopt at least one change in direction, or fold, so as to produce a compact design. Preferably, there are three parallel, concentric, acoustic paths and two folds. A second embodiment has an internal horn that is concentric and internal to the actuator. A third embodiment uses a tubular horn where an electroactive stack is encircled by the horn. The device may have a hollow core for the transfer of materials from one side to the other. The addition of the folds to the horn allows for the introduction of constructive bending vibrations that can be used to enhance the amplification or to alter the phase of the vibration, and therefore provide an additional degree of freedom in the design of horns. The object of this invention is to provide for the design of compact configurations of vibration mechanisms, which are lightweight, compact and can be manufactured with a minimum of waste during fabrication.